Appendix 6. Best Practices in the Professional Development of Educators
Work Session Summary
September 26-27, 2009

Work Session Objectives

- To identify common elements in COSEE professional development programs
- To develop a portfolio of examples of COSEE Professional Development models based on published literature
- To develop a suite of COSEE best practices in the professional development of educators, including frameworks, teaching strategies, and other similar parameters
- To identify and discuss solutions to the challenges of engaging scientists in the professional development of educators
- To identify and discuss solutions to the challenges of recruiting and retaining educators for COSEE professional development programs
- To identify best practices in successful transfer to the classroom and the production of education materials based on COSEE professional development programs
- To identify post-program engagement strategies

Work Session Participants

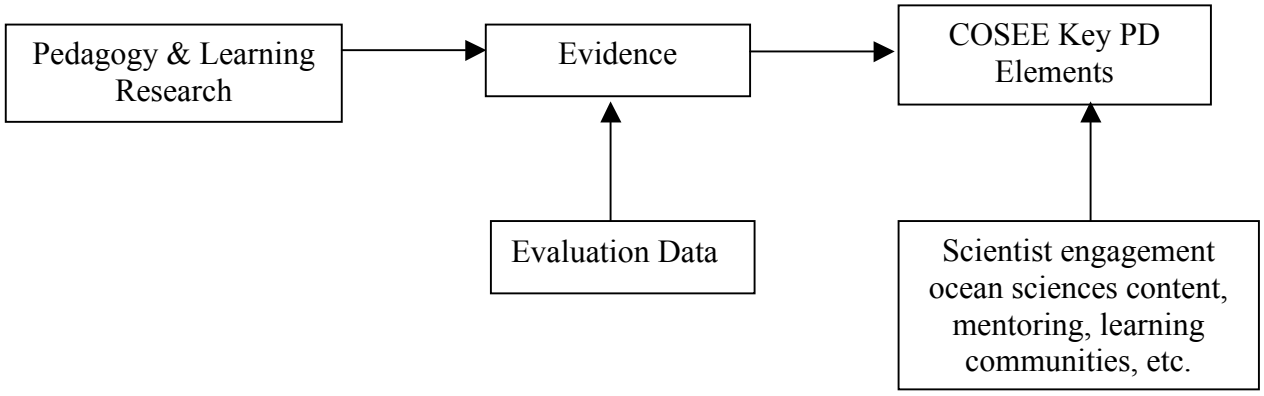
Phil Bell	COSEE Ocean Learning Communities	pbell@u.washington.edu
Pam Castori	National Network Evaluation	pcastori@inverness-research.org
Helen Domske	COSEE Great Lakes	hmd4@cornell.edu
Catherine Halversen	COSEE California	chalver@berkeley.edu
Linda Duguay	COSEE West	duguay@usc.edu
Don Elthon	National Science Foundation	delthon@nsf.gov
Liesl Hotaling	Central Coordinating Office	lieslhotaling@yahoo.com
Andrea Kecskes	Central Coordinating Office	akecskes@gso.uri.edu
Patricia Kwon	COSEE West	pkwon@aqmd.gov
Sage Lichtenwalner	COSEE Networked Ocean World	sage@marine.rutgers.edu
Laura Murray	COSEE Coastal Trends	murray@hpl.umces.edu
Chris Parsons	COSEE Networked Ocean World	cp@word-craft.com
Romy Pizziconi	Central Coordinating Office	romy@gso.uri.edu
Ted Repa	COSEE Ocean Systems	Theodore.Repa@touro.edu
Susan Ross	COSEE Central Gulf of Mexico	susan.ross@usm.edu
Gail Scowcroft	Central Coordinating Office	gailscow@gso.uri.edu
Marilyn Sigman	COSEE Alaska	msigman@alaska.edu
Lundie Spence	COSEE SouthEast	lundie.spence@scseagrant.org
Elizabeth Vernon	COSEE SouthEast	elizabeth.vernon@scseagrant.org
Sharon Walker	COSEE Central Gulf of Mexico	sharon.walker@usm.edu

Representatives from each COSEE Center, the Central Coordinating Office, and the National Evaluation Team participated in this two-day work session focused on the Network's best practices in the professional development of educators. What follows is an executive summary of the discussions and outcomes.

Recommendations from National and Center Evaluators Discussions

There are three main components of a best practices discussion:
1) Research - what we know from the literature, both science and pedagogy
2) Evidence - evaluation data related to COSEE's goals and objectives
3) COSEE Professional Development elements – unique to COSEE such as scientist engagement and ocean science content

Determining COSEE's best practices follows this model:



Review of Best Practices in Educator Professional Development Literature
(Recommended literature is cited in Appendix I.)

It is important to consider power dynamic issues involving educators and scientists in professional development activities. Time is needed for interactions between educators and scientists, and managing power differentials between the teachers and between the teachers and scientists is critical. Formats of these activities should be based on peer-reviewed literature. The literature recommends the inclusion of key elements such as long-term commitments by scientists and educators, reflection for all participants, and science education pedagogy instruction as well as science content instruction. It is also important to cover science misconceptions.

"Following up" with participants is critical in developing communities of practice. The development of social capital[1] is a result of the communities of practice. It deepens the exchange, builds trust among the group (i.e., sharing of knowledge, resources, and support), and allows for effective collaboration on common endeavors. Additional fields of research are needed to understand how to bridge different cultures (e.g., anthropology, cultural differences, and network building).

Key Elements in COSEE Educator Professional Development

Prior to the work session, a survey was administered to the Centers that collected data on the key elements in their educator professional development activities. The survey results informed the work session agenda and discussions. Survey results can be found in Appendix II.

Scientist Participation
When engaging scientists in the professional development of educators, there are two major categories to consider: scientist recruitment and participation. A third category is incentives for scientists to participate. Agencies have encouraged ocean science education outreach by requiring scientists to engage in education and outreach for achieving broader societal impacts of their funded research.

COSEE representatives need to network with scientists to increase the numbers of scientists affiliated with COSEE Centers and programs. Scientists can assist COSEE by teaching, giving lectures, leading

[1] Social capital is defined as the building of communication, connections and communities that strengthen ocean science education. This definition is based on the Draft COSEE Cornerstone Claims document.

field/lab exercises, and providing research experiences. The COSEE Network can assist scientists by honing their communication skills and conveying their science educators and the general public.

Scientists should be members of the Center management teams. Having scientists on the management team allows them to serve as Center liaisons to and within the ocean sciences community. It is important for the Centers to be visible in the ocean sciences research institutions. For example, COSEE-OLC is physically relocated in the Oceanography Department and the collocation has proven a key ingredient in developing relationships.

Several Centers fund graduate students as COSEE assistants. This process provides students an opportunity to develop sound communication skills and to investigate other career paths for the future. It is important to track graduate students after their participation to determine impacts on their future activities.

The group recommended regular COSEE sponsored lunches and poster sessions at COSEE institutions to bring together staff and faculty from schools of education and science departments. An example of successful integration of science and education communities is the COSEE-OS concept mapping development workshops. Scientists are provided with a tool that they can use in their own instruction.

The group recommended that scientists not just be engaged for a lecture. Scientists should have a pre-event/program orientation with data about the participants whenever possible and take part in some type of pre-lecture activity (like concept mapping or a field exercise). Scientists should then remain for a post-lecture activity such as a critique of their lecture or a question and answer period with educators and the general public. Participant feedback should be provided to the scientists. Centers should plan hands-on activities and provide curricula around the content in the scientists' lectures.

Centers should provide scientists with "take away" products such as posters, concept maps, and videos of their presentations. Centers should create a climate that makes the scientists feel special by distributing media announcements and recruiting participants for their education and outreach work, providing supplemental materials to their lecture, and providing technical assistance during the event.

One of the most effective models of transfer of ocean science to teachers and students is a teacher research experience (TRE). It was recommended that NSF funded scientists be encouraged by COSEE to apply for supplemental funding to provide a TRE. The COSEE Network could coordinate and collaborate in "building" a TRE community..

Recruiting and Retaining Educators

Centers should have a teacher recruitment plan for each year. To expand its reach, it would be best for the COSEE Network to work with existing networks such as NSTA, NABT, NMEA, or similar, professional organizations, to recruit teachers new to COSEE. Centers need to take a marketing approach to recruitment and utilize past participants to help "tell their story".

Teachers need to understand the goals of Center programs and goals need to be specific. Recruiting efforts need to reflect goals and desired impacts. A clear application process is key. Once recruited, teachers should be given contracts and clearly defined expectations. It is imperative to share COSEE's success with broader audiences through newsletters, research and education journal articles, scientific and education conferences, and online media.

Teaching Strategies

Key strategies in providing ocean sciences content to educators include:
• using constructivist pedagogy, use of multiple learning styles
• connecting to participants' previous knowledge
• address misconceptions in science
• allowing for a diversity of learning styles.
• modeling inquiry-based activities, field experiences, research experiences, and other hands-on experiences
• aligning activities with the national science education standards
• delivering geographically relevant content
• empowering participants with a knowledge-to-action focus: literacy is not just science concepts
• create a learning community for scientists and educators, building mutual respect and trust
• applying online tools and providing access to real scientific data
• tying themes into regional concepts
• providing defined themes/science concepts/teaching concepts
• sustaining the learning community and keeping the communications going with list-servs, blogs, Wikis

Recruiting Educators from Underrepresented and Underrepresented Populations
The COSEE Network can its increase its engagement with educators and scientists from populations underrepresented and underserved in the ocean sciences through innovative partnerships and strategies in recruitment and engagement. Broadening participation in COSEE activities needs to be a central focus. It is helpful to have a scientist or educator in the field from an underrepresented population on Center staff and/or advisory boards. The COSEE Network needs to partner with organizations that do an enviable job of reaching diverse audiences. One suggestion is that the COSEE Network could engage the 12 Equity Assistance Centers funded by the U.S. Department of Education to discuss strategies for recruitment and Center staffing. These Equity Centers are charged with promoting equity and equal opportunity for race, sex, and natural origin.

To achieve broader participation in Network and Center activities COSEE needs to:
• identify and recruit role models from all levels - scientists, teachers, students, and the general public – to participate in program activities
• partner with the minority serving institutions, multicultural organizations, and federal agencies that encourage broader participation
• host program activities in areas of greater racial and cultural diversity, such as urban and coastal rural areas.
• coordinate activities with greater relevance to underserved audiences and implement more multicultural strategies that are appropriate for different cultures, genders and abilities
• identify contacts that can broker the partnerships among diverse organizations
• tie activities to the families of the students.
• demonstrate active engagement with diverse audiences by integrating people from underrepresented populations into staff and advisory boards
• incorporate local community knowledge and traditional ecological knowledge into ocean science content
• identify incentives for broader participation in the ocean science workforce

The Development of Quality Education Products Resulting from Professional Development
Many Centers require participating educators to produce classroom lessons and activities. Other requirements include posters, websites, PowerPoint presentations, CD-ROMs, and on-line data and related products. Ensuring the activities and products are of a high standard can be challenging. The

group recommended that, in general, educators should adapt tested activities rather than developing new ones from scratch, unless the project includes field-testing. Materials should also be time-stamped so that Centers can remove outdated products from their databases and websites. Scientists should be involved in vetting the science content of activities. If a comprehensive vetting process is not possible, a disclaimer should be included in all materials. The COSEE Network could develop a Network-wide excellence rating and set of criteria for teacher-developed materials.

To ensure educator-produced products are closer to an "excellent" standard, there must be quality control. Questions were raised about the Network adopting a consistent standards based format, rubrics or checklists, and review criteria.

Access and dissemination are critical components for Centers to consider. If time and resources are spent in requiring educators to develop materials, they should be made widely available. Discussion centered on ensuring that suitable products can be posted to NMEA's *Bridge* website with COSEE being identified on all pages. A branding guide with branding conventions needs to be developed.

Successful Transfer of Ocean Sciences Content to the Classroom

Best practices in educator professional development includes modeling how the content should be delivered. It is important to map the content standards, thereby allowing educators to more easily determine the sequence of content within the curriculum. It is imperative that school administrations be engaged in the process of recruiting teachers and in classroom transfer.

Teachers need to know ocean sciences concepts, but they also need to understand more about the latest learning science research in how they are learned, at what ages, and other related parameters. The COSEE Network fulfills a niche in helping educators interpret ocean sciences content through the following six strands:

1.) development of an interest and motivation to pursue knowledge – ocean sciences are personally relevant
2.) scientific knowledge and concepts - ocean sciences are integrative, systems thinking
3.) engagement in building scientific explanations and arguments - ocean sciences are interdisciplinary
4.) engagement in particular scientific practices
5.) understanding the scientific enterprise - direct interactions of scientists
6.) identification with the scientific enterprise - students can leverage science that interest them but also contribute to it, e.g., as new discoveries to be made or new technologies

Post-program Engagement Activities

It is important to create communities that are maintained with regular communication. Over time teacher and educator leaders in schools and informal science centers should be cultivated. These audiences are key in the dissemination of ocean science content. Centers should engage participants in post-program face-to-face and/or online activities, including in on-line social networking environments.

Former participants can assist with recruiting and Center communications. These former participants can serve as mentors during COSEE program activities and even conduct their own professional development activities.

If participants are required to develop and/or implement education activities or materials, Center staff should "follow-up" to provide guidance, evaluate the transfer's effectiveness, and encourage

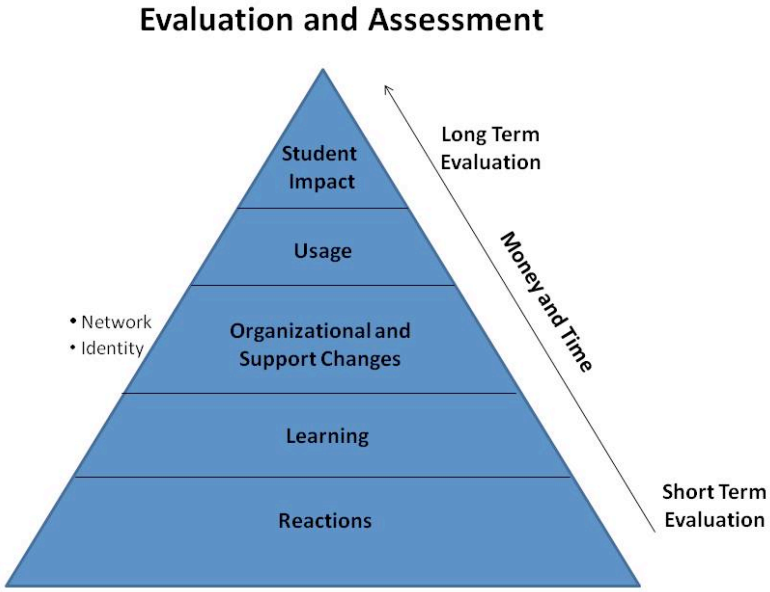
participants to share with their colleagues. If the participants are master teachers, they should be required to mentor novice educators as part of the program's design.

Evaluation and Assessment – Tools and Metrics for Measuring Success

Front-end/needs assessment data are important to gather including what do educators already know about the topics, what are their barriers to teaching it, etc. Formative and summative types of evaluation are also critical for COSEE Professional Development activities. Annual evaluation results must be incorporated into the next year's activities. Pre-test/post-tests are used across the Network to determine gains in content knowledge. So it is essential to have specific concepts tied to the scientists' content.

A daily reflection tool can assist Professional Development providers with gauging understanding of science concepts and participant needs. Scientist participants should also be asked to reflect on their experiences. Scientists also need feedback on how well they communicated and how their efforts will transfer to educators, students and informal learners.

A recommendation is that Centers use Thomas Guskey's method for evaluating Professional Development seen below. This method hallmarks process and identifies deep structures and impacts. It is important for COSEE to align program/activity evaluation to the Network's goals and objectives and unique characteristics.



Evaluators should be included in the planning stage for Center Professional Development activities. If the activity is tied to a Research and Development effort, the evaluation should focus on how the tool/product is being utilized; how the scientist and educators react to it; and what can be done to improve it. The Center PI and evaluator need frequent communication to determine changes needed to improve the tool/product.

Evaluators should participate in Center leadership meetings. This interaction provides an opportunity for threaded discussion between both evaluation and programmatic work. Metrics should include mechanisms to measure building a community over time, focusing on the network of people, and extent and quality of collaborative relationships.

"Follow-up," on-site evaluation is expensive and time consuming. However, it may be very advantageous to strategically follow a subset of participants for conducting a longitudinal study of impacts of particular program activities.

Post-program scientist interviews are important, particularly as they lead scientists to see their own gains in pedagogical skills. Participant feedback is key in assisting scientists to assess " how" they can more effectively communicate in the future.

Mentoring Strategies

1.) COSEE staff mentoring educators

Staff members are essential in providing mentoring to participants prior to and during their time with scientists. Staff mentoring also better enables the participants to teach ocean concepts in classes where it is not required. Staff members should actively participate in the participants' reflective practice. Mentoring should focus on accomplishing some aspect of science content or pedagogy and not be abstract.

Center Professional Development activities should be designed with mentoring as a component. Opportunities for staff mentoring include:

- Staff presence in classroom during implementation
- Presenting together at conferences
- Publishing collaboratively
- Collaborative research opportunities between scientists and educators or students
- Modeling and applications- coaching debrief
- Informal interactions, including meals and breaks (longer)
- Networks, journals, and blogs

Center staff members can offer teachers assistance with the National Board certification process or design their Professional Development activities to create products that teachers can use for this purpose in assembling and documenting their portfolio of evidence.

2.) Scientists mentoring educators

Ideally, mentoring is a two-way interaction in which scientists and educators both benefit. It is important to articulate that mentoring is not only occurring with scientists mentoring educators, but also with educators mentoring scientists. Scientists and educators have unique expertise that they are able to share in Professional Development activities with extended opportunities for interaction. Creating collaborative activities in which scientists and educators work together during Professional Development sessions are mechanisms to make this happen organically.

Scientists learn about Ocean Literacy, K-12 science content standards, how to adapt their research to the classroom, and ways in which curricula and hands-on activities enable student learning. A scientist who gave a complex discussion on nitrification within the ocean concluded her interaction in being mentored by two teachers on learning pathways to present research in a way accessible to middle school teachers, and later collaborated with these two teachers in developing a unique education and outreach program for her NSF Career award.

Educators learn about science content and learn how to collaborate with scientists in improving or developing curricula and hands-on activities suitable for use in the classroom. For mentoring to take place, scientists and educators need to understand the background of whom they will be working with during the Professional Development activity. Centers should develop separate guidelines for scientists

and educators to prepare them for the upcoming Professional Development programs. Several Centers have developed or are in the process of developing these guidelines. Guidelines should include background information on scientists and educators and information on topics and hands-on activities to be covered.

Scientists can provide content questions/answers to be used in pre-tests for educators prior to the implementation of Professional Development programs.. Scientists can take a pre-orientation survey while educators take a pre-test on content knowledge at the beginning of the Professional Development activity. Time should be allocated in the program agenda for small group discussions for scientists to speak with the educators about the "nuts and bolts" of their research and for educators to speak to scientists about integrating ocean sciences into their classrooms.

The development of a collaborative product between scientists and educators promotes two-way mentorship. Opportunities include:

- scientists provide research publications for the educators
- scientists and educators presenting at scientific or education conferences on products from Professional Development programs
- scientists working with educators to write papers published in scientific or education journals based on products from Professional Development activities
- retreats where scientists, educators, and informal exhibit design staff incorporate cutting edge research into informal science center exhibits and making the content usable in the classroom
- building relationships through collaborative mentoring and development of scientist and educator leaders

3.) Educators mentoring educators

Educator to educator mentoring could be defined as (models):

1) Participants who work together in a workshop
2) Teachers who work with other teachers as leaders in their respective school or school district
3) Past teachers return to mentor new teachers
4) Seasoned teachers mentor novice teachers within a workshop
5) COSEE educators working with mentor teachers

COSEE staff members need to establish the scenario/tone/expectations from the beginning of the process. If teachers will be working with each other in teams, an intent should be to create a learning community. Educators express that they prefer to work together in a workshop. This "team" approach helps to build confidence levels with content and interacting with scientists.

Teachers who work with other teachers as leaders in their own schools or school districts can sustain the effects/momentum of the program This "team" approach also facilitates the sharing of resources and identification of new and/or supporting resources. "Spin-off" activities are value-added to COSEE. Much of this anecdotal information has not been fully assessed or reported within the COSEE Network; we need to be capturing and publishing more of these types of significant events for documentation, as well as strengthening our models.

When past participants return to mentor new teachers it can assist with recruitment, building trust, incorporating materials, and school district "buy-in". This mentoring process also helps Center staff with the social/intellectual adjustment and promotes near-peer interactions.

When teachers are all new to the program, matching seasoned teachers with novice teachers within the new cohort can be a significant benefit. This scenario has been documented to help the novice educators adapt resources to their respective classrooms. Seasoned teachers can assist novice teachers avoid mistakes and provide guidance with curricula/resources. Veteran teachers can also help novice teachers to "bend the rules" around the regulations/standards and still meet the standards while infusing ocean principles into existing standards-based teaching.

Overcoming Obstacles and Contributing to the Field

One of COSEE's challenges is to effectively transition current and topical ocean sciences from higher education into K-12 and informal science education. Centers have expressed that although they may have an excellent product, there are obstacles in motivating teachers to use those products. Time, effort and money are needed to develop the product. Just because the product is made available on the web, it's not necessarily going to be used. One way to overcome this challenge is to engage educators in pilot-testing. A cross-Network activity could be to take some Center products and test them with educators in other Centers. This would achieve a higher percentage of educators implementing activities/products. The COSEE Network should explore working with publishers, an effective mechanism to get materials in the hands of teachers.

Another challenge is the vetting of educational materials with teachers and scientists. Pilot-testing of the materials is time and resource consuming. A solution is to facilitate a mechanism to better field-test the materials so they may be posted on-line and shared with confidence. Another solution is to bring in graduate students to help work with a small group of teachers to pilot-test the materials in classrooms across the states the represented by COSEE.

It is imperative that COSEE document impacts: what has COSEE changed that didn't exist seven years ago? The answer to this question poses various challenges. The case studies being collected by the COSEE-CGM team may help with the answer(s) to this question. The COSEE Network has changed the landscape in the ocean sciences community. Scientists were not engaged in education and outreach to this degree and ocean sciences content was not being adequately incorporated within curricula.

It is also important to gauge what is significant about the processes each COSEE is implementing, in terms of outcomes and/or impacts. How have the people involved in COSEE shifted over the years? It is important and challenging to capture catalytic events and unanticipated benefits of COSEE activities. The partnerships that COSEE has within the Network have really helped with expanding the impacts. The whole really is greater than the sum of the parts.

Collaborations and Partnerships

COSEE partnerships could leverage the dissemination of Professional Development models, tools, and products. The group discussed the possibility of working with NSTA SciLinks to integrate ocean sciences into their materials. Partnerships within the Network are improving its overall impacts of the Network. Coordination and collaborations with other organizations with similar interests (i.e. Sea Grant) have been extremely beneficial. It is important to have external partners serve on the Center and National Advisory Committees.

What partnerships should each Center have?

- Business and industry partners for sustainability (bring in MBAs who have the business perspective to help sort through business relationships, branding, logo issues, and other similar issues)
- Underserved institution and association partners (i.e. HBCUs, MSIs, and other appropriate groups)

Exemplary COSEE Professional Development Models Based on Literature and Evaluation Results

• COSEE-Central Gulf of Mexico: Scientist-Educator Summer Institute, multi-day, face-to-face followed by multiple online sessions and the Sea Scholars Program, sponsored by the U.S. Navy in placing teachers at sea from 7-10 days to work side by side with oceanographic surveyors (when ships are available)
• COSEE-Great Lakes: RV Lake Guardian Teacher Research Program, weeklong shipboard program. Teachers provide data to US EPA
• COSEE-Great Lakes: Summer Field Research in Roatan - weeklong field research experience
• COSEE-Ocean Systems: Scientist-Educator Collaborative Workshops - multi-day, face-to-face followed by multiple online sessions
• COSEE-Coastal Trends: Scientist-Educator Institute – six week, face-to-face followed by multiple online sessions
• COSEE-West: Ocean Observing Workshops - multi-day, face-to-face followed by online sessions
• COSEE-California: Communicating Ocean Sciences Workshops - multi-day, face-to-face
• COSEE- Southeast: Scientist-Educator Summer Institute - multi-day, face-to-face
• COSEE-Ocean Learning Communities: Ocean Inquiry - series of day-long retreats
• COSEE-Networked Ocean World: Climate Change Program Development Series - multi-day, online
• COSEE-Alaska: Alaska Seas and Rivers Curriculum Writing Workshop - face-to-face
• COSEE Pacific Partnerships: Community College Faculty Institute - multi-day, face-to-face

Future Directions for COSEE's Professional Development of Educators

Future COSEE Professional Development of educators should integrate technology. This integration will allow for greater impact on greater numbers of participants. The COSEE Network can be on the "cutting edge" of assisting scientists in making their data more accessible to educators on-line; provide a context for the visualizations developed by ocean observing systems; and serve as an interface between scientists and educators in the web environment.

The COSEE Network's future needs to include additional partnerships if its Professional Development efforts are to reach more diverse audiences. This includes moving COSEE materials and products to inland states. If every Center "reached out" to one inland state, it would dramatically improve COSEE's reach. The COSEE Network should investigate the possibility of partnering with large ocean sciences research initiatives to serve as their bridge to educators.

A gap analysis would help to identify where COSEE needs to focus its future Professional Development efforts. The group discussed content priorities including the areas of watersheds, deep-sea exploration, climate change, learning science, social networks, natural hazards, ocean and human health, and conservation.

Appendix I
Literature Used to Develop COSEE Professional Development Activities

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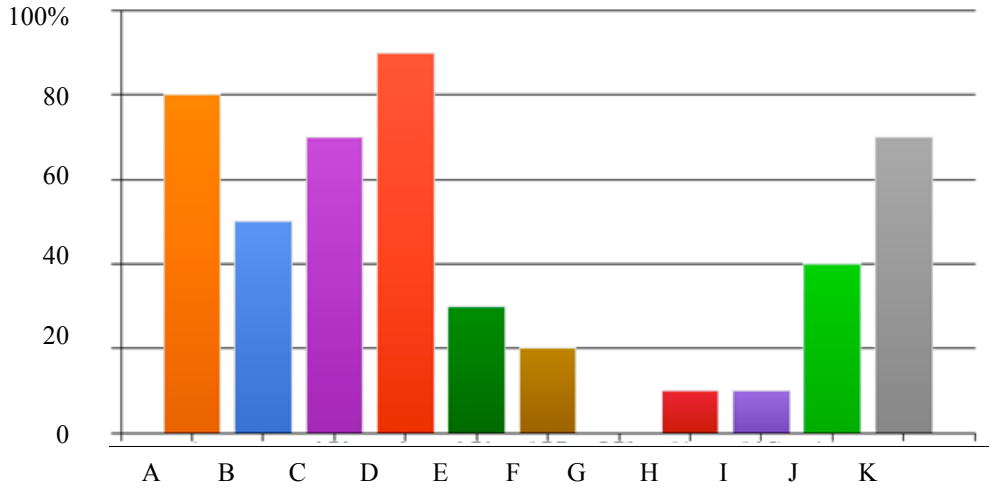
Appendix II

COSEE Center Best Practices in Educator Professional Development Survey
September 2009

All 11 active COSEE Centers completed this survey prior to a two-day work session focused on the best practices in the professional development of educators. What follows here is a summary of survey results and analysis of key findings.

Most Centers (9 out of 11) conduct one-day face-to-face PD programs. These are followed closely (8 out of 11 Centers) by multi-day, residential, face-to-face programs, and by multi-day, face-to-face programs followed by online interactions (7 out of 11 Centers). It is clear that a significant amount of time and resources are going into COSEE one-day, face-to-face PD programs. It is imperative that the impacts of these programs be measured and their best practices described.

Types of Center Professional Development Programs



Types of Programs	%	#
A. Multi-day, residential, face-to-face	**72.7**	8
B. Multi-day, non-residential, face-to-face	45.5	5
C. Multi-day, face-to-face, followed by online interactions	**63.6**	**7**
D. One-day, face-to-face	**81.8**	**9**
E. One-day, face-to-face, followed by online interactions	27.3	3
F. Series of 1-day face-to-face sessions over time	27.3	3
G. Series of 1-day face-to-face sessions over time & on-line interactions	0.0	0
H. Mix of multi-day and 1-day face-to-face sessions over time	9.1	1
I. Mix of multi-day and 1-day face-to-face sessions over time & on-line interactions	9.1	1
H. Multi-day, on-line or virtual programs (including webinars, courses,etc.)	45.5	5
I. One- day or one time, on-line or virtual programs (including webinars, courses,etc.)	9.1	1
J. Graduate courses for formal or informal science educators	45.5	5
K. Certificate programs for formal or informal science educators	9.1	1

Survey comments on other types of PD:

1.	One-day, face-to-face on a research vessel (as opposed to a meeting room environment for response "D")
2.	Our future format will comprise thematic courses (online workshops) consisting of multiple online sessions tied together with online asynchronous discussions, ideally with a face-to-face to start.
3.	In-class coaching, In-class modeling Teaching Practicum (participants try out new approaches with real students, usually observed and/or video taped) Structured reflection

Sharing/Collaborating with peers (like professional learning communities)

4. Our Scientist-Educator Partnership program is 7 weeks during the summer with a follow-up workshop.
5. evening lecture with a scientist followed by an educator special session

As mentioned above, one-day, face-to-face programs comprise the highest percentage of PD programs and they are offered by 9 of the 11 Centers. As seen from survey data below, an average total of 25 of these programs are offered each year throughout the Network. Multi-day residential and multi-day followed by on-line interactions tie for the next most offered programs. The number of participants per cohort vary across Centers and types of programs. The majority of programs have between 19-15 participants as seen in the data below.

Program Type	**No. per year, all Centers**	**Ave. No. Participants per Cohort/No. Centers**						
		<6	7-12	13-18	19-25	26-50	51-100	> 100
Multi-day, residential	14			3	3			1
Multi-day, commuter	10			2	2			1
Multi-day, face-to-face, followed by online	14		2	2	3			
Single day, face-to-face	25		1	2	3	1		1
Single day, face-to-face, followed by online	7				2			
Series of one-day, face-to-face sessions over time	3			1	1			
Mix of multi-day & one-day sessions over time	6			1				
Multi-day, on-line	4		1					2
Graduate course	7	2	1	1				
Certificate program	4			1				
Others	11	2			2			

The following table provides a summary of the average number of scientists that participate in each type of PD program. The number of times each type of PD program is offered each year throughout the Network is included for reference (as it is included in the table above).

Program Type	**No. per year, all Centers**	**Ave. No. Scientists per Cohort/No. Centers**						
		0	1-2	3-4	5-6	7-9	10-11	> 12
Multi-day, residential	14	2		2	1	1	1	2
Multi-day, commuter	10			2	2			1
Multi-day, face-to-face, followed by online	14		2	2	3			
Single day, face-to-face	25		1	2	3	1		1
Single day, face-to-face, followed by online	7				2			
Series of one-day, face-to-face sessions over time	3			1	1			
Mix of multi-day & one-day sessions over time	6			1				
Multi-day, on-line	4		1					2
Graduate course	7	2	1	1				
Certificate program	4			1				
Others	11	2			2			

Each Center identified one of their PD programs that does a good job of integrating best/effective practices in educator PD (as determined from the literature) and their Program Goals. The following survey results relate to these programs.

1. **COSEE Ocean Learning Communities**
   Citizen Science Regional Conference, multi-day, face-to-face
   In collaboration with the Port Townsend Marine Science Center and the Washington State Puget Sound Partnership, COSEE-OLC hosted a two-day workshop in April 2009 entitled 'Exploring the Spectrum of Citizen Science.' The workshop addressed two key issues that many marine naturalists, volunteers, scientists and educators are challenged with; engaging the larger public in marine science, and helping citizens better understand the role of the ocean in their daily life. The event was our first workshop outside of Seattle and was sold-out, with more than 160 persons attending. Friday evening Professor Bruce Lewenstein, from Cornell University, presented on "Citizen Science: What makes it citizen? What makes it science?" Dr. Lewenstein is a leading authority on public communication of science and technology and has done extensive work evaluating citizen science outreach projects including efforts with the Cornell Laboratory of Ornithology. Saturday offered an array of activities including panel sessions on various aspects of citizen science and a poster session focusing on citizen science topics and current ocean/marine science. The event saw COSEE-OLC expand its reach into government scientists, with more than forty marine scientists attending the meeting, many of whom had never attended a COSEE event before. We believe that signature elements of the event included: leveraging the expertise of the interdisciplinary group assembled; grounding our discussions in multiple case studies of teaching, learning, and action associated with the various citizen science efforts; a leveraging of research knowledge on learning and on the work of science to highlight salient features of the activities, and efforts made to support participants in mapping the case studies, issues, and strategies back to their specific program contexts.
2. **COSEE Networked Ocean World**
   Climate Change Program Development Series, multi-day online
   This is one of a series of webinars courses planned, which will engage the educator community most directly. Participants in this webinar series will work together to share expertise and knowledge around the science and curriculum development and youth development skills necessary to create a successful program. A successful program is defined as one that focuses on the relevance (the so what? factor) of climate change science on at-risk youth in urban environments.
3. **COSEE California**
   YO (Youth & the Ocean) Ocean Science & Literacy Academy, multi-day face-to-face plus teaching practicum
   1. To help teachers to incorporate the strategic, synergistic integration of science and literacy into their teaching practice;
   2. To provide a "super-enriched" summer school experience for under-represented and under-served middle school students that improves their academic capacity to succeed in future science courses.
4. **COSEE Ocean Systems**
   Scientist-Educator Collaborative Workshops
   Scientists learn a (typically unfamiliar) pedagogical technique that aids in translation of their research for a variety of audiences; Educators help scientists improve their communication skills by sharing their understanding of good education practices and "real-world classroom scenarios"; Educators become more comfortable with Climate Literacy and Ocean Literacy content and can better evaluate its relevance to their audiences; Scientists and educators are trained on multimedia tools that can benefit their own target audiences; Scientists and educators form product-oriented, peer-based relationships that are sustainable beyond the workshop event (e.g., through online collaboration).
5. **COSEE Southeast**
   Ocean Sciences Education Leadership Institute
   1) Increase scientist-educator collaboration in topic of climate change in the southeast
   2) Provide best practices of pedagogy
   3) Develop leadership skills to extend content to peers
   4) To develop mechanisms that enhance communication of all participants (scientists, educators, COSEE SE staff) throughout the year.
6. **COSEE Coastal Trends**
   Scientist-Educator Partnership, other
   to advance the teacher's scientific inquiry skills and understanding of research associated with our changing coastal ocean and to develop the communications skills of the scientists and graduate students.

7. **COSEE West**
   OOS Workshop, multi-day, face to face

8. **COSEE Great Lakes**
   Lake Guardian Shipboard & Shoreline Science, multi-day, face-to-face
   To have teachers live and work alongside scientists aboard the R/V Lake Guardian to actually conduct monitoring research and interact with other scientists at several locations around the particular Great Lake.

9. **COSEE Central Gulf of Mexico**
   Multi-day, face-to-face, followed by online interactions
   1. Enhanced ocean sciences content knowledge by participating educators (formal and informal);
   Enhanced knowledge of pedagogy and state/national standards by participating scientists;
   3) Enhanced environmental literacy by the general public who visit our Informal Centers;
   4) Positive evaluations (cognitive, affective, and over time [longitudinal]);
   5) Increased engagement between scientists and educators (formal and informal);
   6) Continued efforts to increase underrepresented/unserved participating (scientists and formal/informal educators);
   7) exemplary revised and/or newly developed curricula (lesson plans)--based on sound science; and
   8) Continue "pushing" the technology window for formal/informal educators.

10. **COSEE Alaska**
    Alaska Seas and Rivers Curriculum Writing Workshop
    Provide professional development in standards-based science education pedagogy.
    Provide science content and Alaska ocean scientist research stories.
    Facilitate teacher planning and development of lesson plans and units.

11. **COSEE Pacific Partnerships**
    Community College Faculty Institute
    * Provide community college faculty with knowledge about marine habitats with a focus on the Pacific Northwest.
    * Provide classroom-ready materials and field and laboratory activities related to the topics.
    * Establish a network of community college faculty that teach marine science.

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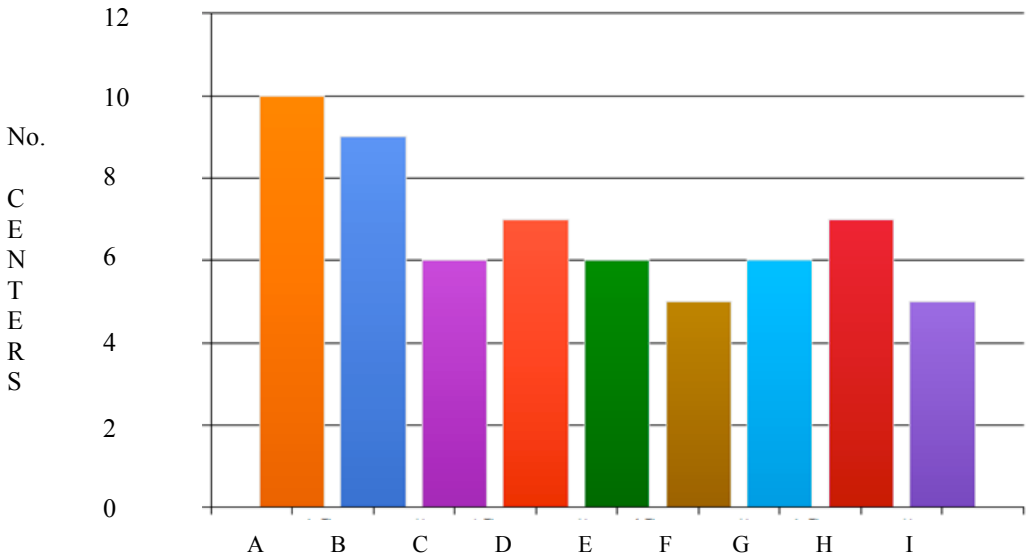
Key Elements of Professional Development Programs



Key Elements	%	#
A. Ocean science content instruction for educators by scientists	**90.9**	**10**
B. Ocean science content instruction for educators by education and outreach professionals	**81.8**	9
C. Instruction for educators in science ed. pedagogy by learning scientists/higher ed. faculty	54.5	6
D. Instruction for educators in science education pedagogy by E&O professionals	63.6	7
E. Opportunities for educators to engage in field-based ocean science research	54.5	6
F. Opportunities for educators to engage in shipboard ocean science research	45.5	5
G. Opportunities for educators to engage in lab-based ocean science research	54.5	6
H. Opportunities for educators to engage in field exercises led by scientists	63.6	7
I. Opportunities for educators to engage in field exercises led by E&O professionals	45.5	5

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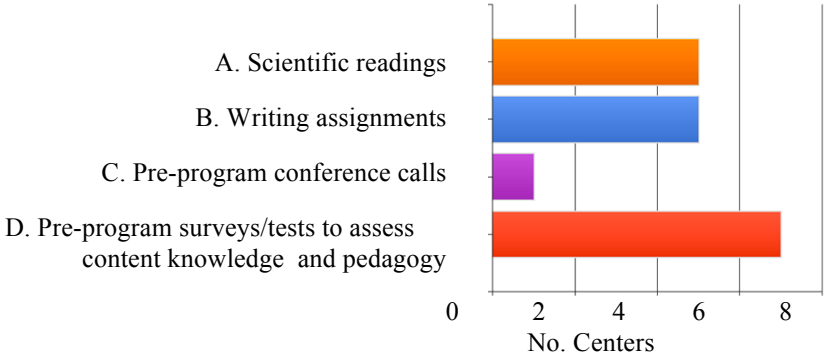
Pre-progra

m Requirements for Participants



Pre-Program Requirements	%	#
A. Scientific readings	62.5	5
B. Writing assignments	62.5	5
C. Pre-program conference calls	12.5	1
D. Pre-program surveys/tests to assess content knowledge and pedagogy	**87.5**	**7**

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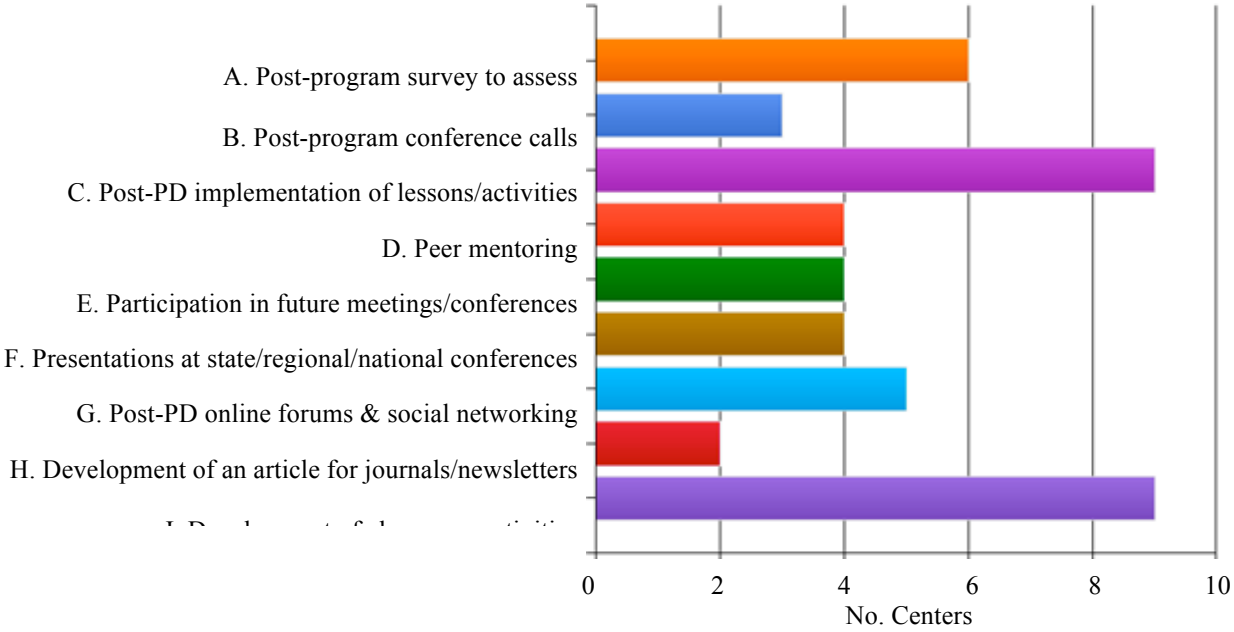
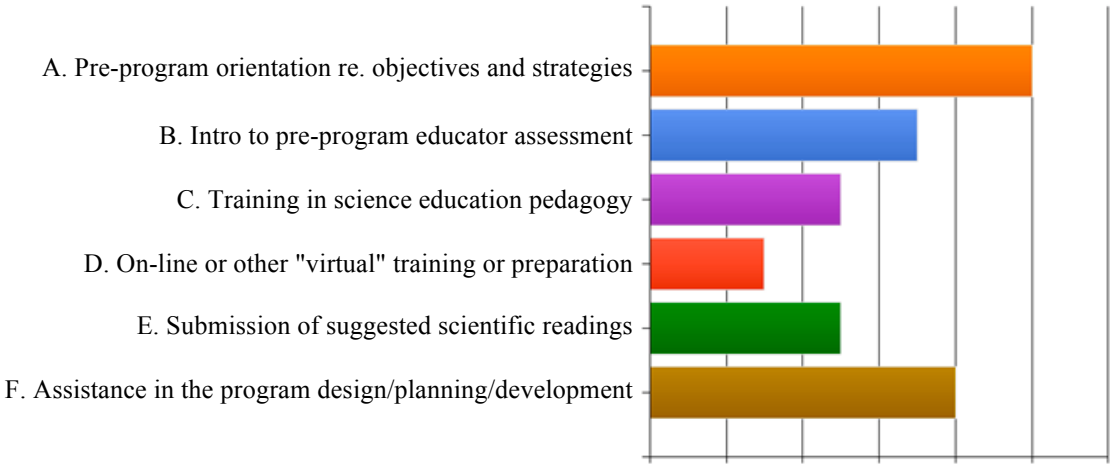
Post-Program Requirements



Post-Program Requirements	%	#
A. Post-program survey to assess content knowledge and pedagogy	54.5	6
B. Post-program conference calls	27.3	3
C. Post-program implementation of lessons/activities/resources	**81.8**	**9**
D. Peer mentoring	36.4	4
E. Participation in future meetings the Center or conferences	36.4	4
F. Presentations at district, state, regional, or national conferences	36.4	4
G. Post-program participation in online forums and other social networking communication	45.5	5
H. Development of an article for journals/newsletters	18.2	2
I. Development/modification and implementation of classroom activities	**81.8**	**9**

Scientist Preparation



Scientist Preparation	%	No.
A. Pre-program orientation to program objectives and strategies	**90.9**	**10**
B. Intro to pre-program educator assessment regarding content knowledge, grade levels, and subjects taught	63.6	7
C. Training in science education pedagogy	45.5	5
D. On-line or other "virtual" training or preparation	27.3	3
E. Submission of suggested scientific readings for participants' preparation	45.5	5
F. Assistance in the program design/planning/development	72.7	8

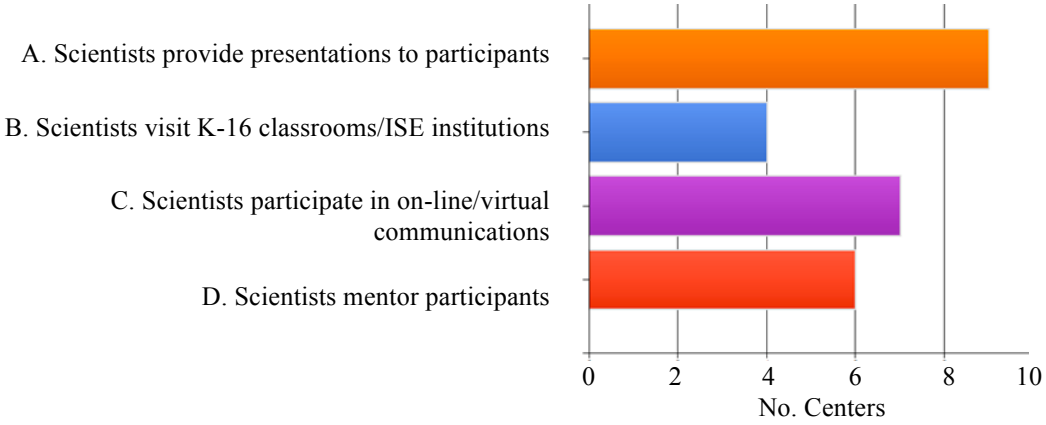
Other Preparation Strategies

1. COSEE CA
   Scientists do not play a significant role in the YO Academy. The survey wouldn't let me leave this blank. In other PD programs (MARE Leadership Institute, Communicating Ocean Sciences Instructors Workshop, Bodega Research Camp, etc.) in which scientists are deeply involved, scientists complete a., b., f.
2. COSEE CT
   Training in communication skills
3. COSEE CGM
   Various e-mails/phone calls in soliciting scientists to participate in either the face to face (one week component) or the two-week, online component (for a minimum of three days) for engagement/participation needs by the scientists. The scientists normally prepare PowerPoint presentations and work with real-time. near, real-time data or streaming video.
4. COSEE AK
   Scientists were recruited based on the content and concepts that were the focus of the curriculum development.

Description of Scientist Training

1. COSEE OLC
   We leverage the 'science of learning' expertise within our team to orient participants to how and why people learn, to unpack their assumptions about teaching and learning and scientific work, and to orient to the varied cultural positions and background of learners from different demographic backgrounds and the implications for educational equity. We have an evolving cohort of scientists involved in the center and learning about these issues is interwoven in our activities -- from working meetings to formal presentations. It is difficult to estimate the duration. These are just issues we discuss in ongoing ways.
2. COSEE NOW
   1) Technical training to gain comfort presenting in the online environment. 2) Review of best practices to engage participants in online discussions and how to best present content (visually, narratively and cognitively)
3. COSEE CA
   When scientists are involved in our PD efforts, they don't need "training" since they are integral to the project, they have helped with the planning, and may even be experienced in whatever it is we are asking the participants to implement following the PD. In the case of COS Instructors Workshop, the scientists delivering the PD have taught the COS course.
4. COSEE OS
   Prior to the arrival of the participating educators, scientists receive training on concept mapping techniques. Scientists create and present maps that are tied to their own research and designed for a specific audience (e.g., first-year college students not majoring in science). Scientists present their maps to educators and receive feedback on the maps' appropriateness for the intended audience. Immediately afterwards, pre-set teams of scientists and educators (nominally at a ratio of 1 scientist to 3 educators) reach consensus on a "focus question" and target audience. Within this framework, scientist-educator teams spend several hours creating collaborative maps that are hyperlinked to images, videos, news, and teaching resources in the COSEE-OS database. All participants also learn how to copy, customize, and share (by email) maps for their own post-workshop uses.
5. COSEE CT
   4 day orientation program for all team members
6. COSEE West
   Scientists are usually individuals we have worked with and are provided with instructions that lecture should be at a level for an educated public and not to use a lot of science jargon. We review the powerpoint presentation and critique it if requested by the scientist
7. COSEE GL
   Scientists interact with COSEE GL staff to prepare them for their experiences via phone calls and emails (3-4 hours). Scientists also read education research articles to introduce the profession. Some scientists attended COSEE GL "school for scientists" sessions at the International Association of Great Lakes Researchers Conference.
8. COSEE CGM
   We have a "guide" which is provided to the online scientists, to include multiple e-mails and several phone calls. We also implement a videoconference to "go over" the guide and respond to any questions the online scientists may have. For the scientists who are involved in the face to face component, the PI and Co-PIs work with 5-7 different scientists to help them prepare for their 5/6 day involvement with the 12 middle school teachers. Formal/Informal Educators are involved with research scientists from collaborating on lesson plans, to listening to one another's professional "scope of work," to working together in the field, to select visits to scientists' laboratories, to having meals togehter, to much, much more! An extremely positive paradigm shift occurs during these "face to face," one week sessions, offered in two Gulf of Mexico states each summer.
9. COSEE AK
   Series of email or phone conversations about the concepts that are the focus of curriculum development.

Post-program Scientist Engagement



Post-program Scientist Engagement	%	#
A. Scientists provide presentations to participants as resource	**81.8**	**9**
B. Scientists visit K-16 classrooms or informal science education institutions	36.4	4
C. Scientists participate in on-line chats or other virtual communications with participants	63.6	7
D. Scientists mentor participants	54.5	6

Other Comments

1.	COSEE NOW D is two-way.
2.	COSEE CA Scientists are not involved in YO Academy. When scientists are involved, they are usually engaged in d. I could not leave the question blank.
3.	COSEE SE 2009 Initiates an on-line forum for educator-scientist communication
4.	COSEE GL Not all scientists visit classrooms or mentor participants.

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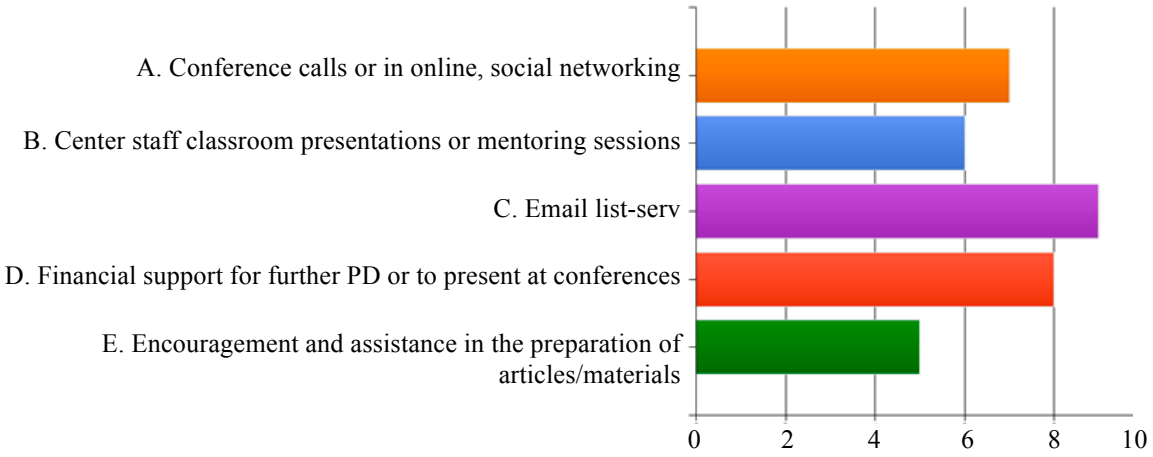
Center Post-Program Support for Participants



Center Follow-on Support	%	#
A. Center staff/participant conference calls or in online, social networking communications	63.6	7
B. Center staff travel to participants' institutions for classroom presentations or mentoring sessions	54.5	6
C. Center staff provide an email list-serv	**81.8**	**9**
D. Center financial support for further PD or to present at scientific conferences	72.7	8
E. Encouragement and assistance to participants in their preparation of written/materials	45.5	5

Other Comments

1. COSEE CT
   Follow-up workshop
2. COSEE GL
   Our online engagement includes Center staff sending and responding to participants' emails regarding follow-up activities, resources that are available and other elements related to the experience.
3. COSEE CGM
   The COSEE-CGOM website is a "go to" resource for both formal/informal educators and scientists, as well as the 12-Member COSEE-CGOM Advisory Board and 12 -Member Management Team.
4. COSEE PP
   We plan to meet with participants again at appropriate locations to follow up with what has been implemented and to provide further opportunities for PD. We plan to put materials developed on the COSEE PP web site for others to use.

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The percentage of Centers that require the development of classroom materials for their designated program: 81.8% (9 Centers)

Comments on the Development of Classroom Materials

1. COSEE OLC
   We do that work in other PD activities in the center through collaborative design partnerships and classroom studies, but not this one.
2. COSEE NOW
   For this particular series, it is envisioned that the group will develop a prototype suite of activities (and/or kit).
3. COSEE CA
   Teachers use published, research-based, highly evaluated ocean sciences curriculum materials. They adapt these materials to insert opportunities for: reading informational text for a variety of purposes (create context, support first hand investigation, support 2nd hand investigation, model science processes, etc.), engaging in dialogic discourse, and writing and notebooking.
4. COSEE OS
   Participants are required to produce at least one concept map linked to images, videos, teaching resources or news items. They present the resulting map(s) to the participating educators and scientists.
5. COSEE SE
   1. One learning module
   2. One 6-hour professional development event for peers in their local area.
6. COSEE CT
   The number of lessons is not required, but typically participants have developed between 8-12 activities/lessons
7. COSEE West
   The teachers are paid a stipend of $500, if they attend all 5 days and develop a OOS-related lesson plan which is posted on the COSEE-West website for use by other teachers
8. COSEE GL
   Depending on the program, educators have been required to create assessments (tests), classroom activities, outlines for units of study, research reports and powerpoint presentations.
9. COSEE CGM
   During the one week, face to face component of the Summer Insitute, offered in two, Gulf of Mexico states each summer, one PD Program is developed by one scientist and approx. 2-3 middle school teachers. During the six,

online scientists' presenations (two per week over a three week timeframe with the actual time spent "online" being no greater than two weeks), each teacher develops and/or revises one lesson plan per six topics. Over the course of two, Summer Institutes, each having 12 participants and each participant completing seven lesson plans, the COSEE:CGOM will have approx. 150 new/revised lesson plans, all in a consistent fromat, aligned with the National Science Education Standards and the Ocean Literacy Essential Principles and Fundamental Concepts....and, linked to the five, Gulf of Mexico State Standards.

10. COSEE AK
Educator teams of 4 develop a draft unit with 4 or 5 lesson plans.

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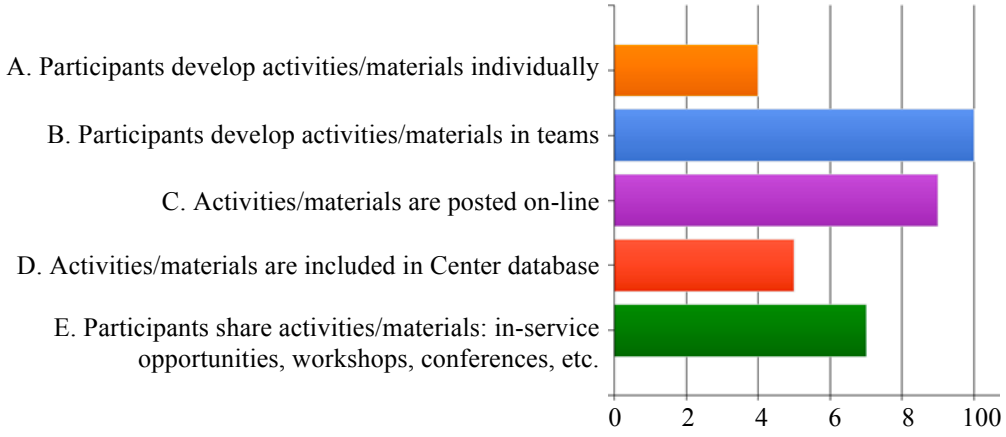
Aspects of Classroom Activities



Aspects of Classroom Activities	%	#
A. Participants develop activities/materials individually	36.4	4
B. Participants develop activities/materials in teams	**90.9**	**10**
C. Activities/materials are posted on-line	81.8	9
D. Activities/materials are included in Center database	45.5	5
E. Participants are required to share activities/materials with colleagues through in-service opportunities, workshops, conferences, etc.	63.6	7

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Expectations for Classroom Transfer

1. COSEE-OLC
We have some evidence that the science of learning research helps the educators think about and revise their educational activities. We have some evidence that the community-focused activities expand the social networks of the participants, allowing them to draw upon each other's expertise / projects in more nimble ways. We know that educators have become involved with a number of the specific efforts we have showcased and discussed. We know that the PD experiences have caused some educators to consider new professional activities and occupations (e.g., to become an educational researcher). We have evidence that scientists become better communicators of their science by orienting to how people learn and specific pedagogical approaches. They also strengthen their E&O activities by connecting to ongoing efforts and by tapping into networks of educators / citizens.

2. COSEE-NOW
Educators will gain best practice information on how to construct activities on the subject of climate change, including adapting content to informal environments, at risk and multicultural communities, and leading community service projects.

3. COSEE-CA
They transfer the results immediately to summer school students during the highly scaffolded professional development academy itself. Then they are expected to further transfer what they have learned/experienced to their own classrooms during the academic year.

4. COSEE-OS
The educators are expected have their students directly access (online) the maps they produce during the workshop. Some

educators "share" the maps with their students who, in turn, alter the maps in the "Concept Map Builder" and add links to resources of their own choice.

5. COSEE-SE
Implementation of lessons, plans and activities presented during the Institute by December 2009.

6. COSEE-CT
Participants use activities in their classrooms

7. COSEE-West
Expectation is that teachers will be able to use in their classrooms the hands-on activities that they are presented with over the week and provided to them in the OOS workshop workbook

8. COSEE-GL
The teachers share in writing how they will use what they learned in their classrooms. There is flexibility in expectations to match diverse teaching situations.

9. COSEE-CGM
The face to face PD program is completed by the team of two to three teachers and one scientist and is supposed to be presented to the respective teachers' schools and/or school districts and on some occasions, the involved scientists also co-present. For the online developed lesson plans, the PI/Co-PIs for COSEE:CGOM select the best of the best of these activities....which are then posted on the COSEE:CGOM website.

10. COSEE-Alaska
Educators will pilot lesson plans or entire units with their students and some will become trained facilitators to disseminate the lesson plans and pedagogy to other teachers who will in turn use them with their students.

11. COSEE-PP
Use the material presented in their courses

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Methods for Tracking Teacher Progress

1. COSEE-OLC
We do not do this kind of work.

2. COSEE-NOW
formative assessments, online discussions (and other public interactions with other community members)

3. COSEE-CA
Site visits, follow up surveys. We are following the "success" of students, as well, but the students have also had a variety of other interventions (after-school research experiences, service learning, residential research camp, weekend field trips, tutoring and college counseling).

4. COSEE-OS
Several "case studies" with specific educators / classrooms have been implemented to track progress on using COSEE-OS tools/resources over time.

5. COSEE-SE
On-line surveys and conference calls and visits during professional development events

6. COSEE-CT
Participants report on how they used the activities during the follow-up workshop

7. COSEE-West
required to turn in a lesson plan. and are tracked through follow up surveys

8. COSEE-GL
Follow-up surveys and interviews from the project evaluator.

9. COSEE-CGM
We track the teachers in "following through" with their commitment in presenting and providing the remaining half of their stipends through each teacher's building principal providing us a letter indicating the teacher presented a PD program in his/her school district or through formal presentations at state, regional, or national meetings via the participants sending us (PI/Co-PI) a copy of the program for the meeting in which he/she presented. Our evaluator also conducts post-surveys requesting some of the informaton cited in question 17, as well as select interviews with three teachers from each state the fall semester following the Summer Institute in two states and in the spring semester as well. Scientists are also surveyed following the Summer Insitutes.

10. COSEE-AK
Professional development credit depends of a report about implementation of an activity.

11. COSEE-PP
Surveys

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Retaining Participants

1. COSEE-OLC
   We encourage participants to join the COSEE-OLC online community, send out an email list of participants who attended a particular event, provide an online COSEE-OLC newsletter, and invite participants who have attended previous programs to future ones. We have formally and informally surveyed participants about what future programming they might want to participate in.
2. COSEE-NOW
   They are brought into the COSEE NOW online community where they can become members and continue discussions started in the virtual meetings, interact with the larger community on other subjects, follow topical blogs on related subjects, and receive notices of newly developed resources (including podcasts).
3. COSEE-CA
   We are working with this cohort of teachers as part of a 3-year funded effort.
4. COSEE-OS
   All participants are added to "COSEE-OS Directory" and provided interactive documentation of their workshop experiences, including full suite of maps created, video presentations, etc. In addition, all participants are registered to use COSEE-OS online tools and thus are periodically invited to participate in online community events (e.g., web-based training sessions when new tool functionality is developed).
5. COSEE-SE
   Retained because of listserv communication and invitations to participate in other events, additional assessments and responses to questions.
6. COSEE-CT
   yes
7. COSEE-West
   they usually join the COSEE-West oceanlist server
8. COSEE-GL
   They are invited to join other programs, some serve as mentors for follow-up programs.
9. COSEE-CGM
   Participant engagement is usually continued through e-mails by the PI/Co-PIs and our COSEE:CGOM Newsletters.
10. COSEE-AK
    They are invited to become a member of SEANET, the interactive listserve and google group.
11. COSEE-PP
    E mail list serve
    Participation in meetings that both the faculty and COSEE-PP attends. Special sessions for the Faculty offered by COSEE - PP

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Major References Used

1. COSEE-OLC
   (NRC volumes) How People Learn, How Students Learn, Taking Science to School, Learning Science in Informal Environments: provides consensus foundation on cognition, learning and characteristics of generative learning environments and experiences

   (LIFE Consensus Report) Learning in and out of school in diverse environments: Highlights social, cultural, and institutional aspects of learning; a more holistic, ecological account that engages issues of equity head on

   Ann Brown on "Design Experimentation" and many others on reciprocal educational design partnerships (including some pieces I've written): describes how PD and educational improvement can both be advanced through a collaborative, iterative engineering of learning; it ties into how educating is a design enterprise that can be informed in a refinement of the approach in relation to an empirical investigation of learning

   Loucks-Horsley et al. Designing PD: as a guiding framework for thinking about a system of PD experiences relative to the aims of education; but we have had to develop new approaches and models for specifically engaging with informal educators (citizens) and scientists -- to help them in developing and refining their pedagogical and communication practices
2. COSEE CA
   Loucks-Horsley et al 2003
   Garet 2001
3. COSEE-NOW
   We're reviewing the literature but this is a new field and there is very little published data available.
4. COSEE OS
   Bransford, J., A. Brown, and R. Cocking (1999), How People Learn: Brain, Mind, Experience, and School, 374 pp.,

National Academy Press, Washington. D.C. => Scientist - educator collaboration on concept mapping helps clarify the importance of connections in science, rather than memorizing facts ("Research shows that it is not simply general abilities, such as memory or intelligence, nor the use of general strategies that differentiate experts from novices. Instead, experts have acquired extensive knowledge that affects what they notice and how they organize, represent, and interpret information in their environment. This, in turn, affects their abilities to remember, reason, and solve problems.")

Novak, J. and D. Gowin (1984), Learning How to Learn, 199 pp., Cambridge University Press, New York. => Seminal document on concept mapping

Probing Understanding, White, R., & Gunstone, R. (1992). London: The Falmer Press => Active learning, for example through consensus-based concept mapping, is a key element of the workshop design. Together, scientists and educators deconstructing their knowledge of topics and reconstruct key concepts into a cohesive story for a third audience (e.g., the students for whom their maps are intended).

5. COSEE SE
10 Professional Development section in National Science Education Standards, National Academy Press 1996
Various articles and experiences with ASTE
2) Educating Teachers, National Academy Press, 2001

6. COSEE CT
personal experience on implementing a teacher research program for over 12 years

7. COSEE West
OOS workshop was based on our prior experience with day long teacher workshops and a previously developed workshop by Laura Murray of COSEE Coastal Trends

8. COSEE-GL
Cooperative learning and advance science preparation, as demonstrated in Mayer, V.J., R.W. Fortner and W.H. Hoyt. 1995. Using cooperative learning as a structure for Earth Systems Education workshops. Journal of Geological Education 43(4):395-400.

Methods and workshop design in Mayer, V.J. and R.W. Fortner. 1995. Science is a Study of Earth. A resource guide for science curriculum restructure. Columbus, OH: The Ohio State University, Earth Systems Education Program. 246 pp. On line at http://earthsys.ag.ohio-state.edu/project/pubs/scienceis.html

9. COSEE CGM
Our participating scientists provide research content and the PI/Co-PIs provide educational research reports for our formal/informal educators to review. We also have an area on our website for resources, upcoming meetings, and similar information in which the teachers and scientists may have an interest.

10. COSEE AK
The PD model was designed by a team; many team members relied on research that I did not review.

11. COSEE PP
The PD model was designed based on a needs assessment with community college faculty rather than based on any specific research reference. For faculty PD, the following reference is influential in guiding our ideas but many community college faculty are not lacking in pedagogical knowledge rather they need current ocean science information: Handelsman J, Ebert-May D, Beichner R, Bruins P, Chang A, DeHaan R, Gentile J, Lauffer S, Steward J, Tilghman S, Wood W. 2004. Scientific teaching. Science 304:521-522. In addition, we use the experience from the NSF funded Faculty Institutes for Reforming Science Teaching that showed that using a residential setting , such as a marine lab, helps to better facilitate formation of a community of learners in a workshop setting.

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Evaluation Methods

1. COSEE-OLC
Formally, we use surveys, quick feedback forms, interviews, and systematic observations. Informally, we solicit input and reactions from participants and collectively share our understanding of how things have gone through debriefing sessions.

2. COSEE CA
We have conducted several NSF-supported evaluation studies over the last 20 years.

3. COSEE-NOW
Formative assessments after each online meeting to ensure participants needs are being met. Still developing long-term evaluation strategy.

4. COSEE OS
As part of pre-workshop application and post-workshop
evaluation processes, educators answer questions about their "Comfort level with" and "Relevance to (their classrooms)" of target Climate Literacy and Ocean Literacy content. Educators are also evaluated pre-workshop to discover their "level of interest in using ocean-climate examples to fulfill (targeted) National Science Education Standards." Educators'

answers are used to: 1) "match-make" them with a workshop scientist based on their needs; and 2) determine if the workshop resulted in a measurable change in their
perception of "comfort" and "relevance" of the Climate or Ocean Literacy content. Scientists receive direct feedback from educators on their initial concept maps in terms of: 1) capturing the "big picture"; 2) use of jargon; 3) effectiveness of the map; and 4) clarity of the "take home message." Scientists are also interviewed post-workshop regarding their overall experience, value in concept map training, and suggestions for improvement (e.g., staff interactions, workshop format, online tools, etc.). In the near future, COSEE-OS plans to hold follow-on events to evaluate how participants have incorporated concept mapping processes and tools into their practice.

5. COSEE SE
Pre-, Post-assessment and pedagogical gain instruments, interviews, portfolio submissions, terminal surveys, daily journals

6. COSEE CT
internal/external evaluators

7. COSEE West
post-survey of the participants, repeat participation in our various programs

8. COSEE GL
Baseline study of scientist and educator perceptions of collaboration. Initial surveys of educators and scientists before arrival; journals examined at middle and end of workshop; concept maps begun on Day 1 and built along the way to chart conceptual growth; followup surveys and selected interviews of scientists and educators at 6-month, one-year and two-year intervals.

9. COSEE CGM
Face to Face and online pre- and posttests for the teachers, Likert-scale evaluations for scientists and educators, post-electronic surveys (scientists and eduators), interviews with scientists at the "face to face" institute and select interveiws (three/state) for two consecutive semesters following the Summer Institute. For the two-day workshops, the evalutors also pre- and posttest the partcipants and all participants (to include the scientists) provide Likert-scale evaluations.

10. COSEE AK
Pre- and post-surveys; follow-up surveys of teachers in terms of implementation, including those who were subsequently trained in use of the curriculum.

11. COSEE PP
End of session survey by external evaluator and then follow up surveys to determine implementation

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Evaluation Results

1. COSEE-OLC
In year one COSEE-OLC was focused on building a learning community within and across the Oceans and Human Health constituencies at the University level and linking the OHH group with identifiable groups in the broader public. Despite intensive efforts it became clear this OHH group was unwilling or unable to undertake the types of signature education-focused activities imagined by the COSEE-OLC group.

With a change of focus to the marine-focused volunteer groups, COSEE-OLC co-sponsored a meeting with key organizers and leaders, followed by an online needs assessment, an evening celebration event for approximately 130 volunteers from several of the organizations, and a planning session for subsequent activities.

During years three and four of the COSEE-OLC project the professional development component with the marine-focused volunteer groups has relied on two strategies:
1. an evening social event with keynote speaker followed by a full day of workshops; and
2. an evening event centered around a keynote speaker with ancillary activities in support of community building.

These professional development experiences have been highly successful based on survey evaluation data, and the tweaks that have occurred are largely that of insuring the ocean sciences, the learning sciences and the informal education elements have equal representation.

2. COSEE CA
We have evaluation results for MARE PD that show increased hours of science instruction, increased hours of ocean science instruction, increased amounts of integration especially between science and language arts, improved school "climate and culture," and increased degrees of teacher collegiality. In the Communicating Ocean Sciences Workshops, we have evaluation data that show a very high percentage of people attending the workshop end up teaching the course, and that teaching the course effects/changes the way they teach other science courses. We also observe that teachers' knowledge and beliefs change long before their practice does, so the PD needs to be extended for long enough to effect practice, say 3 years.

3. COSEE-NOW
None to date

4. COSEE OS
Participating educators have rated the "quality of

interaction with scientists' an average of 6.9 (out of 7.0 maximum) and 88% felt that they communicated with scientists as "peers/colleagues." 88% of educators also felt that the process of concept mapping helped them think through the topics covered in the workshop. Evaluation data for all workshop applicants has provided insight into educators' "comfort" with Climate Literacy (CL) and Ocean Literacy (OL): based on specific content covered in the workshops, educators are most comfortable with "All watersheds drain to the ocean… (OL-1g)" and "Life on Earth can influence climate… (CL-1d)." Educators are least comfortable with "Use of mathematical models is now an essential part of ocean sciences… (OL-7e)" and "Observations, experiments, and theory used to construct and refine computer models… (CL-2c)." These "least comfortable" OL and CL content examples also received the lowest scores in terms of "relevance" in pre-workshop application surveys. However, 79% of educators who participated in the workshops became "more comfortable" with CL-2c ("Observations, experiments, and theory…) and 64% found this content "more relevant" after the workshop. In post-workshop interviews with participating scientists, all see the advantages of using concept maps over PowerPoint because of ease of use, but more importantly because "Concept maps better represent graphically how I think." They also encourage training graduate students to concept map using COSEE-OS online tools.

5. COSEE SE
Results of pre-post workshop assessments show "significant" gain in both content knowledge and confidence to teach, interviews and daily journals reveal need for more processing time and positive support for the format.

6. COSEE CT
Participants report that they have learned from the experience. While the development of the education module is a great mechanism for learning, it can be all encompassing at times.

7. COSEE West
Feedback from OOS/Ocean Literacy Workshop Participants:
§ I am appreciative of the chance to ask others for inquiry ideas for origin of life. The 7 essentials are more useful to me now that we had a chance to relate them to our lessons, teaching.
§ What a treat being here! Favorite part was the tour; Annie did a great job of telling us in down to earth knowledgeable way what we saw up front. Very good overview for me to understand what JPL is. It's always been this nebulous, intimidating monolith in the hills above Pasadena!
§ The infusion of new ideas and the technical information presented by the workshop coordinators.
§ Kevin Hussey's presentation was fabulous--I can't wait to show my students and co-workers. I think that I would've liked David Joy's topic a bit more; it was unfortunate that it was difficult to project it correctly. Thank you for scheduling the JPL tours. It was great to see those areas.
§ It would have been so helpful during the course of the week to tour the UCLA and USC labs to just meet a few profs (whoever is around) and hear a bit about their research. As scientists, it is so invigorating to speak with career scientists. Groundbreaking research even ongoing studies in progress are all of interest to us. This would also seem a natural segue into other discussions and analysis.
§ Really appreciated the expertise of the individual presenters and the team. Great day! I liked learning about phytoplankton. I enjoyed the wave tank demo, seeing how you set it up so quickly. Guided computer tour of the sites relevant to our activity was helpful.

8. COSEE GL
Concept map analyses demonstrate that participants grow measurably in conceptual knowledge and content complexity over the week. Follow up surveys show that both scientists and educators gain greater respect for each other's work, work setting, and "real lives." Baseline study will be repeated near the end of the program for analysis of changes in perceptions of collaboration.

9. COSEE CGM
The pre- and posttests are always signifcant at the 0.05 or 0.01 levels of signifcance (usually the 0.01 level of significance). The Likert-scale evaluations usually range with all activiteis and presenters being 78-92% Very Valuable/Vauable; 7-18% Average Value; and 1-4% Limited/Very Limited Value. For the interviews, please see our Annual Reports on the COSEE:CGOM website.

10. COSEE AK
In progress

11. COSEE PP
From the executive summary of the 2009 community college faculty workshop:
The presenters were ocean scientists involved in active research. The focus of each presenter was to provide data and findings based on their research including conduct of field activities. Each presenter had an extended period of time to work with the participants not just an hour or so to provide a one-way channel of information. The number of participants was limited allowing individual interaction with the scientists. The workshop was conducted over a one week period at a research station with classroom facilities as well as research labs. These factors made the workshop a unique experience. Most faculty professional development at the community college level is focused on direct classroom use of materials. Exposure to research scientists in the setting provided by the workshop is generally reserved for other scientists.
The success of the workshop indicates the COSEE goal of involving scientists in the educational environment is totally achievable at the community college faculty level.

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Major Benefits and Weaknesses of this Program

1.	COSEE-OLC Depending on how you cut it, we have five different programmatic approaches to PD. Here's my summary of strengths and weaknesses that cut across. Strengths: interdisciplinary and diverse adult audience (age, gender, professional backgrounds); connect scientists and volunteers, formal/informal educators, learning scientists; giving scientists experience to practice E & O and get feedback on their communication practices; connecting marine related educational organizations – creating a network where once it did not exist, engaging graduate student scientists in the community early in their careers. Getting this broad network to more deeply consider issues of educational equity. Partnering with organizations like Sea Grant, Port Townsend Marine Science Center, EEAW, Puget Sound Partnership. Weaknesses: not being able to fully track what happens over time for participants who attended our programs, not able to facilitate more connections within the online community, difficulty engaging "senior level" ocean scientists, being able to open the programs up to a larger group.
2.	COSEE CA See evaluation results above
3.	COSEE NOW Online interactions reduce the need for travel and enable teams to work together over longer periods of time as they iteratively develop new resources. Online meetings supplemented with directed forum discussions keep everyone engaged. We have also switched from one-off webinars to constructing threaded series, so we can enable collaborations (instead of just providing content) and foster the development of new resources by teams.
4.	COSEE OS Major benefits: Peer-to-peer relationship building among scientists and educators; Training on widely accessible and flexible tools that promote systems thinking; and Transferability to other Centers. Major weaknesses: Hard to reach technically challenged users (e.g., have found that elementary level educators need a lot of scaffolding to become comfortable with tools); Many educators have negative views of concept mapping based on previous experiences with students (e.g., difficult to assess products with no "right answer); and Have yet to investigate ways to integrate the workshop with other types of "traditional marine sciences workshop" activities (e.g., augmenting a workshop where educators also go out on a boat and take measurements).
5.	COSEE SE Benefits: regional recruitment, focused efforts for diverse participants, engagement of scientists before, during and after the workshop, responsiveness to recommendations from COSEE SE Board of Advisors on topics, networking, extension of workshop to multiple locations throughout regions Weaknesses: Always a lack of processing time, developing appropriate resources with this year's new content focus on climate change -- this resulted in a tremendous amount of upfront effort of staff. In previous Institutes, a weakness has been in assessing educators implementation of workshop content and pedagogy to students -- a new effort has been initiated in 2009.
6.	COSEE CT Benefits: two way communication between scientists and educators Weakness: low number of participants
7.	COSEE West Major benefits are we provide teachers with access to cutting edge science and scientists, provide detailed lessons, activities and resources to use in their classrooms and network the teachers through their participation in our programs and list server.
8.	COSEE GL Major benefit: Teachers actually get to conduct research and their data is used by the USEPA. The evaluator works with them during the program, and they get a feeling of their own science growth through concept mapping. Weakness: Although we have follow-up engagement of educators, we could improve the regularity and intensity of it.
9.	COSEE CGM We need greater numbers of underserved/underrepresented participants--both scientists and formal/informal educators and we need to do a better job in field-testing our lesson plans.
10.	COSEE AK Strengths: Availability of the conceptual framework to guide content presentations and curriculum development, field instruction at a marine science lab, professional development opportunity for participants in science ed. pedagogy aligned with standards. Weaknesses: Insufficient interaction time between educators and scientists, insufficient follow-up to evaluate implementation in the classroom.
11.	COSEE PP Benefits - opportunity for intense focus on marine science topics with NSF funded scientists who are generating new knowledge. Bringing together a group of faculty with common interests. Weakness - Not yet sure if community college faculty will be able to incorporate materials into their classes. We may need

to provide more structure for them to facilitate this.
We don't yet know if we can keep the learning community together in the next year(s).

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Key Design Features that Make the PD Successful, Innovative, and Effective

1. COSEE-OLC
(1) sustained, flexible interaction of an interdisciplinary group of invested participants -- with the goal of promoting relationships and community, (2) strong integration of the details of ocean sciences work and findings, (3) strong integration of science of learning research, (4) focusing on the professional development of multiple groups of participants (educators/citizens, ocean scientists, learning scientists, etc.) -- it is a reciprocal learning experience and collaborative effort, not something being done to "fix" the educators

2. COSEE-CA
All of our PD programs use a structure that generally includes formal PD-->reflection-->practice-->reflection. The practice and reflection are highly scaffolded to ensure that they take place in helpful, productive ways. The scaffolded practice ensures implementation of the desired intervention.
The content is engaging, integrative and useful for addressing both standards and cutting edge science, as is all COSEE PD. We use PD strategies that are based on research in adult learning. But the long term, ongoing nature of the PD that embeds it squarely in teacher practice is our biggest strength.

3. COSEE NOW
Combination of online virtual meetings and asynchronous discussions. Focused webinar series on specific topics. But participants can interact with a larger community of peers on related subjects of interest. Webinar facilitators and topical blogs provide leadership to keep community members interacting by selecting relevant presenters and by asking members to respond to directed questions to spur discourse.

4. COSEE OS
Fostering peer-to-peer collaboration through flexible processes and ever-improving technical support are key to success of the workshops. COSEE-OS is firmly grounded as an "R&D" Center and thus is continually re-evaluating its practice and updating its tools to meet customers' (i.e., scientists' and educators') needs. Likewise, COSEE-OS actively promotes the use of its tools and techniques by other Centers.

5. COSEE SE
1) Lots of personal interaction
2) Diverse format (lecture, activity, field, lab, etc.)
3) Pre and Post Communications
4) Exciting presentations and interactions with scientists
5) Location of Institute at a marine lab

6. COSEE CT
Teams of scientists, graduate students, teachers and underrepresented undergraduate students work together for 6 weeks to develop educational modules.

7. COSEE West
This workshop provides the teachers with a wealth of hands on experiences and classroom activities that they can easily adapt to their classrooms. They are provided a workbook with details on all of the activities they participated in. They are exposed to a different academic institution or informal education institution each day and can draw on those institutions for additional opportunities for their students.

8. COSEE GL
The fact that the teachers live and work elbow-to-elbow with researchers and the data they collect is actually used by the UPEPA makes the experience unique.

9. COSEE CGM
Consistency in all Gulf of Mexico states, field trips, inquiry-based learning, good interpersonal skills/rapport between the scientists/educators/PI and Co-PIs, tenacity of purpose, enthusiasm, excellent website, effective newsletter, passion for ocean sciences eduation, and....the PI/Co-PIs/Educators/Evaluators "listen" to the teachers' and scientists' needs for their classrooms and/or broader societal impacts.

10. COSEE AK
Focus on Alaska science stories and the combination of pedagogy training and content as the foundation for the lesson plan and development development.

11. COSEE PP
Use of marine lab scientists to provide instruction.
Residential setting allowing for considerable interaction between participants.
Mix of field and lab work.
An understanding of participants needs and constraints.

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How Participants Describe Their Learning Experiences
Program Attributes that Convinces Participants that it is a Powerful Learning and Motivating Experience

1. COSEE-OLC
   To answer this question it is important to recall that COSEE-OLC is focused on building a community. The events focused on the marine-focused volunteer groups are intended to amplify a dialog between and among all the members of the interdisciplinary group. Toward that end, the participants in events are encouraged to give feedback as one might with a colleague. The events have consistently received the highest ratings on the value scale. The other questions on the post event survey are designed to garner qualitative feedback that will help the next programmatic effort better meet the needs of the marine volunteers. This information is factored into the planning for subsequent events.
   Perhaps the best indicator of achieving success is the increasing "sign up pressure" the COSEE-OLC team experiences with each event. Approximately half the participants are new to the events — and they have learned to sign up early in order to guarantee a spot. The events are always filled and the registration has to be closed. COSEE-OLC is meeting the needs of the marine volunteer community and word of mouth advertising among volunteers makes this evident.

   The evaluation research has documented these results:
   1. Marine volunteers have increased awareness of potential collaborations with other organizations, and with scientists and science educators in both formal and informal education settings.
   2. Marine volunteers and program staff have gained new concepts of how people learn and are beginning to apply these ideas in workshops and scientific presentations.
   3. Marine volunteers have demonstrated an increased interest in, and capacity to, engage the public in ocean science by using an inquiry approach,
   4. Marine volunteers have explored the use of technology applications that might improve communication between volunteer groups and with the public.
   5. Through the COSEE-OLC project, ocean scientists are able to participate in, and derive benefit from critically observing effective public presentations by peers and being coached in effective public presentation strategies.
   6. Ocean scientists are getting useful feedback about public presentations from the marine volunteer audiences who willing share their effective strategies for reaching the general public.
   7. COSEE-OLC has established partnerships with several broad-based, environmental-focused organizations; providing the foundation for an ocean learning community.
   8. COSEE-OLC has developed materials and products to be shared with the marine volunteer community, including an inquiry workshop protocol for adult volunteers.
   9. COSEE-OLC has generated reciprocal collaboration among the partners, beyond the formation of a marine volunteer learning community.
2. COSEE CA
   In many cases, participants describe it as transformative. They are initially grabbed/hooked by the content itself, but the transformation comes from the combination of PD with high quality instructional materials, and the scaffolded support for implementation, practice and reflection.
3. COSEE-NOW
   No data yet.
4. COSEE OS
   For educators: the unique opportunity to get to know how scientists think by working with them as peers. For scientists: learning a technique that can help them in their everyday lives and the chance to see how other people think.

   (I can provide many "quotable" quotes from our participants. One example: "I was expecting a certain level of interaction with teachers and scientists, but the actual working together on building a concept map was fantastic! I think that this is a wonderful, refreshing vehicle to get two communities of learners together to push science education to new heights!")
5. COSEE SE
   Over 95% consider the learning experiences valuable and inspiring.
6. COSEE CT
   All participants reports that they have learned from each other... the scientists learn communication skills from the teacher and undergraduate students and the teacher and student learn research science from the scientist and graduate student.
7. COSEE West
   Teachers have described the experience as - greatly appreciating the week. It was a great experience to have everyone at the university level - scientists and staff to help K-12 teaches develop the next generation of scientists. They were inspired by the dedication of the scientists and staff. They indicated they were introduced to great ideas, activities and resources that they could implement in their classrooms. Also see evaluation comments above.
8. COSEE GL
   Some have described it as life-changing or indicated that it has greatly improved their scientific understanding. Most indicate that these programs were the best PD experience of their careers. They are actually conducting research, working in labs and coming up with a data set that is used by the USEPA and they comment on how important this is to them.
9. COSEE CGM

Our teachers and scientists "walk away" from our Institutes and/or Workshops "dead tired," but amazed at what they have done together, through increased collaboration and coordination for both research and education! And, the anectodal Likert-scale information for years indicates our TPD Programs are the "best!" Further, the scientists are in "awe" of what teachers "do" in their respective classrooms for this nation's future generations. Lastly, the scientists are "coming back" to us (PI/Co-PIs) requesting our education and outreach input for their "next" proposals.

10. COSEE-AK

Strong appreciation for the pedagogy training that has not been available to them, strong appreciation for the collegiality with both their peers and scientists. Middle school teachers, in particular, expressed how isolated their teaching practice is from real science in Alaska and how exciting it was to hear about current research and findings.

11. COSEE-PP

The evaluation indicated that all 11 participants felt the workshop completely met their expectations. I believe this is because community college faculty have little opportunity to interact with practicing scientists and by providing that COSEE was able to make their experience a very positive one. I also think that they were motivated to participate because we focused on content rather than pedagogy.